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COMPUTER-MEDIATED COMMUNICATION (CMC) AND THE COMMUNICATION OF TECHNICAL INFORMATION IN AEROSPACE*

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Abstract

This paper discusses the use of computers as a medium for communication (CMC) used by aerospace engineers and scientists to obtain and/or provide technical information related to research and development activities. The data were obtained from a questionnaire survey that yielded 1006 mail responses. In addition to communication media, the research also investigates degrees of task uncertainty, environmental complexity, and other relevant variables that can affect aerospace workers' information-seeking strategies. While findings indicate that many individuals report CMC is an important function in their communication patterns, the research indicates that CMC is used less often and deemed less valuable than other more conventional media, such as paper documents, group meetings, telephone and face-to-face conversations. Fewer than one third of the individuals in the survey account for nearly eighty percent of the reported CMC use, and another twenty percent indicate they do not use the medium at all, its availability notwithstanding. These preliminary findings suggest that CMC is not as pervasive a communication medium among aerospace workers as the researcher expected *a priori*. The reasons underlying the reported media use are not yet fully known, and this suggests that continuing research in this area may be valuable.

Introduction

Within the last twenty years CMC has ushered in a new age of communication capability.[1] CMC utilizes the computer as the means of structuring, storing, and processing written communications among groups or individuals, and permits interaction conveniently and rapidly with near or distant persons and/or groups having similar concerns, interests, and goals.[2] Some researchers say that CMC now dominates information exchanges within the United States, and that it increasingly alters how people execute their work.[3] The data in this study do not support such claims entirely, but technology and communication are closely interrelated, and traditional modes of information distribution such as paper mail delivery are being replaced in various degrees by CMC systems.[4]

The literature review of information processing (IP) theory suggests that several variables influence the effectiveness of communication processes among organizational members. This study investigates these relationships within the context of U.S. aerospace workers. The research includes the following variables:

A) Variety and analyzability;
B) Uncertainty and equivocality;
C) Dynamism, complexity, and predictability;
D) Information processing coordination involving CMC as compared to printed documents, voice mail, telephone calls, discussion with liaisons, face-to-face conversations, and meetings.

Against the background of relevant environmental factors cited above, this paper focuses on communication media and discusses the communication habits of individuals who work either directly or indirectly in the aerospace community, principally in research and development activities, although other areas are represented as well, such as administration and management, marketing and sales, and academic research.

Definition of Key Terms

This section defines certain terms, concepts, and specialized vocabulary used in the study: variety, analyzability, uncertainty, equivocality, information richness, dynamism, and predictability.

Variety is defined as the measure of unique or unanticipated events or situations that individuals routinely encounter. High variety implies that there are frequently new problems occurring that require novel approaches to eliminate them. Low variety is characterized by few problems that may occur infrequently.

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Analyzability is somewhat related to variety. To the extent that problems may be anticipated, solutions may also be planned to cope with the problems when they do occur. High analyzability refers to a high capacity to provide procedural methods to solve difficulties. Low analyzability means that methods and tasks are not easily scrutinized to formulate procedures in advance to deal with problems when they do occur.

Uncertainty is defined as the difference that exists between the amount of information that is required and the amount of information that is possessed by individuals. It implies that explicit questions can be formulated and that specific answers to the questions exist somewhere and have to be found.

Equivocality differs from uncertainty in that no specific answers exist, and perhaps the explicit questions have yet to be formulated. Equivocality implies an unclear, messy field caused by ambiguity or the existence of multiple and conflicting interpretations resulting in confusion and lack of understanding.

Information richness is defined as the ability of information to change understanding within a time interval; that is, communications that overcome frames of reference or clarify ambiguity in a timely manner are defined as rich. The exchanges are characterized by multiple context cues, both verbal and non-verbal.[5]

Dynamism refers to degrees of change that take place in the task environment. Highly dynamic environments are usually associated with high levels of uncertainty, because frequent, rapid changes can give rise to problems that require obtaining additional information.

Complexity is related to factors in the environment such as technological characteristics of organizational units, integrating processes uniting individuals, and technological and educational backgrounds and skills required of members, all of which influence the complex dimension. As the complexity of the task environment increases, ability to make precise, significant statements about its functioning diminishes.[6]

Predictability refers to the degree to which task environments and their associated problems can be specified and planned for ahead of time.

Information Processing Approach to Communication

The theoretical framework adopted for this research is principally grounded on the Tushman and Nadler Model of Information Processing (IP).[7] They developed it after the work of Galbraith.[8] The IP model calls for a proper degree of fit between information requirements and information processing capabilities in order to obtain effective communication.

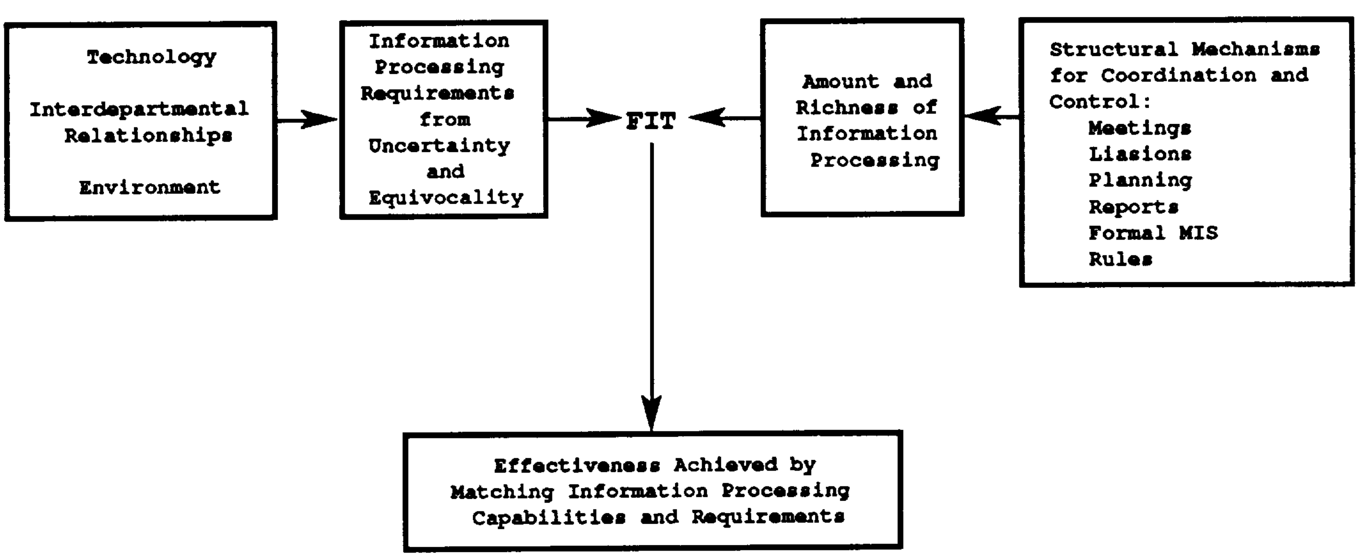

Fig. 1. Daft and Lengel Summary Model of Information Processing Based on Tushman and Nadler (1986)

Improper fit can cause organizations to lag behind goals and expectations with possible negative results. To achieve strategic ends, organizations need to manage information as a productive part of the organization, and this would best be accomplished by fostering communication capabilities to match needs.[9]

Building upon the Tushman and Nadler model, Daft and Lengel also proposed that effectiveness is a function of the degree of fit between information processing requirements and capabilities in their model of information processing illustrated in Figure 1 on the preceding page. They further suggested that using the appropriate levels of information quantity and information richness can help to reduce uncertainty and equivocality.[5]

An approach to environmental variables was put forth by Duncan.[10] As illustrated in Figure 2 below, he identified two orthogonal dimensions of organizational environment: degree of change (static vs. dynamic) and degree of complexity (simple vs. complex). The important point is that factors such as complexity and dynamism affect the overall amount of uncertainty by the organizational members. According to the IP model, uncertainty and equivocality need to be resolved if the members of the organization are to be effective.[11]

Information processing theory holds that equivocality resolution requires an exchange of differing views to define problems and resolve conflict, and theorizes that information-rich communication strategies contribute more effectively to resolving equivocality due to the increased possibilities for shared interpretation.[12] Media of lower richness offer fewer variables for understanding and tend to be less effective in reducing ambiguity or equivocality.[13]

In order to overcome imprecision associated with uncertain environments, individuals will need to process more objective information.[14] With higher levels of uncertainty, written and oral communications will tend to increase.[15]

Environments with high levels of both uncertainty and equivocality tend to have consequent high information processing requirements. Such environments have a multiplicity of poorly understood issues and possible disagreement over what is to be done. These situations require subjective experiences, discussion, judgment, and purposive enactment. Daft and Weick proposed that such an environment is fostered by rapid changes, unpredictable shocks, and unanalyzable technologies.[16]

DEGREE OF CHANGE	Simple	Complex
Dynamic	3. MODERATELY HIGH PERCEIVED UNCERTAINTY (Medium IP Requirements) Small number of factors and components in the environment. Factors and components are somewhat similar to one another. Factors and components of the environment are in continual process of change.	4. HIGH PERCEIVED UNCERTAINTY (High IP Requirements) Large number of factors and components in the environment. Factors and components are not similar to one another. Factors and components are in a continual process of change.
Static	1. LOW PERCEIVED UNCERTAINTY (Low IP Requirements) Small number of factors and components in the environment. Factors and components are somewhat similar to one another. Factors and components remain basically the same and are not changing.	2. MODERATELY LOW PERCEIVED UNCERTAINTY (Medium IP Requirements) Large number of factors and components in the environment. Factors and components are not similar to one another. Factors and components remain basically the same.

DEGREE OF COMPLEXITY

Fig. 2. Duncan Matrix of Environmental Influence and Information Processing Requirements (1979)

Instead of viewing CMC as a vertical communication system used by management with few opportunities for information processing by the organizational members, this study focuses on environments where CMC has the potential to be important for workers who process information as a principal part of their jobs. Today's environments require speed and flexibility, and what is more important, today's communication technologies (such as the CMC emphasis in this research) may allow the attainment of these requirements.[17]

Research Methodology

The Total Design Method described by Dillman constitutes the project's overall strategy and procedures.[18] The survey itself was developed following in-depth discussions involving communication and organization design specialists and aerospace personnel. The survey was pilot tested on several occasions, the last of which involved a subsample of the target population. Some changes were made, but most of them involved editing the wording of the questions whereas the overall constructs and underlying variables that constituted the focus of the project remained intact.

Subjects were randomly selected from a database of United States aerospace workers. Cover letters enclosed with the surveys informed the subjects that participation was completely voluntary, and that the subjects are protected by a policy of confidentiality.

Of the 2000 surveys mailed, 1006 usable questionnaires were returned. In the course of the three-month data collection period, 143 subjects had to be dropped from the study altogether due to bad mailing addresses, death, etc. Babbie states that the normal practice in such circumstances is to disregard the dropped subjects, because the research should not count against itself subjects who were not able to be included in the study for reasons not associated with the subjects' willingness to participate.[19] Therefore, when those unavailable subjects were removed from the total, the study's response rate stood at approximately 55%.

The professional staff at a nationally-recognized center for survey research input the data, and the file was examined for errors by separate individuals. Analysis of the data was performed using Statistical Package for the Social Sciences (SPSS) software. Several techniques were applied to examine the data's reliability. Based on the results, the researcher has a good level of confidence in the accuracy and reliability of the data. A summary of reliability coefficient alpha scales is listed in Table 1 in the appendix.

Discussion of Research Results

As mentioned previously, over half of the subjects contacted in the mailing of the questionnaires responded to the survey (approximately 55%). While this rate of return suggests that the researcher may have a good degree of confidence in the overall validity and generalizability of the findings, some of the results are not entirely clear in their implications. However, strong tendencies regarding the environmental factors and communication practices of aerospace workers have emerged and are discussed below.

Variety and Uncertainty

Measures of variety and uncertainty were each assessed from questions on five-point Likert scales. The unweighted sums of the items (four questions concerning variety; five questions for uncertainty) were computed. The mean score for variety was 15.3 out of a possible 20 (std dev 2.7); the mean score for uncertainty was 12.9 out of a possible 25 (std dev 3.3). Summary statistics are listed in Table 2a in the appendix. Although IP theory postulates that there should be a positive correlation between variety (the independent variable) and uncertainty (the dependent variable), the data in this study do not support that claim. In fact, the exact opposite relation was found: uncertainty is negatively related to variety in this data.

To test the hypothesis that there should be a positive correlation between variety and uncertainty, variety is used as the independent variable to divide the sample into high and low variety groups (first time by using a median split; second time by using the highest and lowest quartile ranges).

After the sample is divided, a t-test of independent means is applied to see if the mean scores of uncertainty are significantly greater ($p < .05$) in the high variety groups. The t-tests indicate exactly the opposite findings than were expected: the uncertainty scores are lower in the high variety group than they are in the low variety group in the median split test ($p < .002$). The same result is obtained in the high quartile variety group compared to the low quartile group ($p < .007$). Results of the t-test are in Table 4.

This finding is an anomaly, and so far cannot be accounted for in the model. One supposition is that there exists an unmeasured latent variable confounding the data, but if this is so, it has not yet been found although further analysis of the anomaly is continuing.

Analyzability and Uncertainty

It will be recalled that high analyzability refers to a high capacity to provide procedural methods to solve difficulties. Low analyzability means that methods and/or problems may not be readily amenable to careful scrutiny to provide formal procedures to deal with problems when they do occur. Perrow took the position that the more analyzable the environment, the less uncertainty will be felt by the workers because procedures can be put into place to handle problems when they occur.[20]

Unlike the unusual findings stated in the previous section, the IP model's prediction of the relationship between analyzability and uncertainty is confirmed in the data on analyzability and uncertainty. Support for this relationship has also been found in recent previous studies involving analyzable environments and communication practices.[21]

To test the hypothesis that there is a negative correlation between analyzability and uncertainty, analyzability is used as the independent variable to divide the sample into high and low analyzable groups using a highest and lowest quartile range split.

After the sample is divided, a t-test of independent means is applied to see if the mean scores of uncertainty are significantly lower ($p < .05$) in the high analyzability group. The results of the t-tests confirm the hypothesis: the uncertainty scores are lower in the high analyzability group than they are in the low analyzability group ($p < .000$). Results of the t-test are listed in Table 6 in the appendix.

Dynamism, Complexity, and Predictability

As environments become more diversified and increase their levels of technological complexity, the volume of communication tends to increase.[22] Hence, communication and organizational structures are closely linked, and communication plays an essential role in making human behavior more efficient.[23] Consequently, it is important to analyze the fit between information requirements and communication capabilities to maximize communication effectiveness.

The data indicate that the aerospace environment is characterized by a high degree of complexity, a moderately high degree of dynamism (change), and an average amount of predictability. The summary data for these dimensions are listed in Table 2a in the appendix.

Consequently, the contextual factors (variables associated with the work environment) of the aerospace environment indicate that there will be moderate to high levels of communication volume, and the survey attempts to quantify these amounts in various scales. Inter-item correlations of the contextual variables are listed in Table 7.

Media Use

The survey data indicate that overall the subjects had a preference for conventional forms of communication media such as face-to-face conversations, meetings, and paper documents than they did for electronic networks. Specifically, the subjects were asked to rate their experience with four main types of media: CMC exchanges (principally, e-mail), oral exchanges, (face-to-face), written materials (hard copy, printed documents), and telephone voice mail systems. The four media types were assessed with respect to the following variables:

A) importance of the information obtained;
B) accuracy of the information obtained;
C) usefulness of the information obtained;
D) specificity of the information obtained;
E) sufficiency of the information obtained;
F) overall ease of obtaining the information;
G) excessiveness of information (overload).

Also, the subjects were asked to rate the relative frequency with they used each of the four types of media in the course of a normal work week. The variables are measured on a five-point Likert scale. For example, for the variable on importance of information obtained, the following range of scores would be illustrative: 1-"Very Unimportant"; 2-"Somewhat Unimportant"; 3-"Neutral"; 4-"Important"; 5-"Very Important" for each of the four types of media. For variables A-F (importance through ease of use), a higher mean score represents more satisfaction with the media. For example, if the voice mail medium receives a mean score of 3.1, and the written document medium has a score of 4.2 on the variable of usefulness, the interpretation is that the subjects were, on average, more satisfied with the usefulness of information obtained from written documents than they were for information received via voice mail. Direction of the wording was the same for all of the variables on the survey. Therefore, the last item, overload, was reverse scored. That is, a "high" score for that item actually represents an overload of information for that medium, and consequently, a high score here represents dissatisfaction.

Results of Media Use

For ease of comparison, the summary data for the four variables with respect to importance of the media are listed in Tables 8a and 8b. Below is a brief description of the main points observed in the different types of media. A summary of comparisons for the variables is in the appendix.

Oral Media

The subjects rated oral communication as the most satisfactory source of information overall. It was rated highest in four separate categories: importance of the information, usefulness, sufficiency, and ease of access.

Written Media

Second to the oral medium in overall satisfaction among the subjects was the written medium, and it was rated best in the terms of accuracy, specificity, and lack of overload.

Electronic Media (CMC)

The third most satisfactory medium was the use of electronic networks. Although it was not rated most satisfactory in any of the categories, it was rated second highest with respect to ease of use, behind the oral medium and ahead of written media.

Because electronic networks constitute the medium of primary interest in this paper (although consideration is given to other media and to variable dimensions of the aerospace task environment that affect communication patterns), much of the data regarding use of networks is summarized in tabular form in the appendix.

Voice Mail

Voice mail was rated the least satisfactory medium of the four. It scored lowest in all of the categories except in overload of information where it was rated the medium most likely to supply an excess of unneeded information.

Conclusion

It should be pointed out that the interpretation of the findings is still in somewhat of preliminary stage, the data having been in the possession of the researcher for approximately five weeks at this writing. Nevertheless, some important criteria have already emerged from the study. For example, to this researcher's knowledge, no previous data are available that measure on a national level the contextual dimensions of the aerospace task environment. In that sense, this study takes an important step in the Aerospace Knowledge Diffusion Research Project by examining environmental variables that affect the communication of technical information. Without such data, it is difficult to make sound recommendations regarding media use.

That having been said, the contextual data indicate that the aerospace environment is characterized by high degrees of variety and complexity and moderately high measures of dynamism with only moderate levels of analyzability and predictability, thereby causing considerable equivocality among the individuals. While measures of variety are also high, the data indicate that there seems not to be a corresponding positive correlation with high uncertainty; in fact, the exact opposite was found. Overall, equivocality is high and uncertainty is moderate.

Communication Strategies

Information processing (IP) theory argues that the best communication strategy, the one that should result in the most effective fit between information requirements and information capabilities, is to use non-rich information media (e.g., written documents or e-mail) to resolve uncertainty and to use rich information media (e.g., face-to-face conversations and group meetings) to resolve equivocality.

The data bear out the predictions of the model. Subjects report the heaviest reliance on the information-rich medium of oral communication to match the highly equivocal aerospace environment. Although they report the leaner media of e-mail to be important, it is not the lean media of choice. They report greater satisfaction using written media than using computer networks. The reasons why are not clear at this time.

Because human communication is so complex, one of the difficulties with research of this type is the large number of variables in the models. All together, this study collected data on 157 variables that are relevant to aerospace communication. Due to space constraints, this paper must forego extended explanation of some variables to provide space in favor of tables in the appendix that summarize the data much more succinctly. The author, upon request, can provide a more discursive explanation of any variables of interest.

Appendix of Table Summaries

Listed below are summaries of tabular data referenced in the paper. N=1006.

Table 1

RELIABILITY ANALYSIS - SCALE (ALPHA) -

RELIABILITY COEFFICIENT - VARIETY
N OF CASES = 996.0 N OF ITEMS = 4
ALPHA = 0.66

RELIABILITY COEFFICIENT - ANALYZABILITY
N OF CASES = 994.0 N OF ITEMS = 4
ALPHA = 0.79

RELIABILITY COEFFICIENT - UNCERTAINTY
N OF CASES = 974.0 N OF ITEMS = 5
ALPHA = 0.68

RELIABILITY COEFFICIENT - EQUIVOCALITY
N OF CASES = 978.0 N OF ITEMS = 6
ALPHA = 0.77

RELIABILITY COEFFICIENT - COMPLEXITY
N OF CASES = 996.0 N OF ITEMS = 2
ALPHA = 0.64

RELIABILITY COEFFICIENT - DYNAMISM
N OF CASES = 996.0 N OF ITEMS = 2
ALPHA = 0.52

RELIABILITY COEFFICIENT - PREDICTABILITY
N OF CASES = 997.0 N OF ITEMS = 2
ALPHA = 0.47

Table 2a

SUMMARY STATISTICS

Overall Variety

Mean	15.34
Std Dev	2.71
Minimum	4.00
Maximum	20.00
Range	16.00

Valid observations - 1004
Missing observations - 2

Overall Equivocality

Mean	22.58
Std Dev	3.95
Minimum	4.00
Maximum	30.00
Range	26.00

Valid observations - 1003
Missing observations - 3

Overall Uncertainty

Mean	12.98
Std Dev	3.39
Minimum	1.00
Maximum	24.00
Range	23.00

Valid observations - 1003
Missing observations - 3

Overall Dynamism

Mean	6.59
Std Dev	1.82
Minimum	1.00
Maximum	10.00
Range	9.00

Valid observations - 998
Missing observations - 8

Overall Complexity

Mean	7.87
Std Dev	1.78
Minimum	2.00
Maximum	10.00
Range	8.00

Valid observations - 998
Missing observations - 8

Overall Predictability

Mean	5.66
Std Dev	1.56
Minimum	2.00
Maximum	10.00
Range	8.00

Valid observations - 999
Missing observations - 7

Table 2b

SUMMARY STATISTICS
CONT'D.

Overall Analyzability

Mean	11.081
Std Dev	3.356
Minimum	4.00
Maximum	20.00
Range	16.000

Valid observations - 1004
Missing observations - 2

Table 3

-- Correlation Coefficients --

	VAR1	VAR2	VAR3	VAR4
VAR1	1.00	.35**	.43**	.31**
VAR2	.35**	1.00	.27**	.36**
VAR3	.43**	.27**	1.00	.22**
VAR4	.31**	.36**	.22**	1.00

	INTUN1	UNCER2	UNCER3	UNCER4	UNCER5
UNCER1	1.00	.35**	.10**	.35**	.23**
UNCER2	.35**	1.00	.26**	.28**	.43**
UNCER3	.10**	.26**	1.00	.21**	.33**
UNCER4	.35**	.28**	.21**	1.00	.39**
UNCER5	.23**	.43**	.33**	.39**	1.00

Table 4

A) MEDIAN SPLIT TEST FOR VARIETY (IND.) AND UNCERTAINTY (DEP.)

t-tests for independent samples:

GROUP 1 - Low Variety
GROUP 2 - High Variety

Variable	Number of Cases	Mean	Standard Deviation	Standard Error
Overall Uncertainty				
GROUP 1	655	13.2153	3.378	.132
GROUP 2	348	12.5316	3.366	.180

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-tail Prob.	t Value	Degrees of Freedom	2-tail Prob.	t Value	Degrees of Freedom	2-tail Prob.
1.01	.943	3.05	1001	.002	3.06	710.01	.002

B) QUARTILE SPLIT TEST FOR VARIETY (IND.) AND UNCERTAINTY (DEP.)

t-tests for independent samples:

GROUP 1 - Low Variety
GROUP 2 - High Variety

Variable	Number of Cases	Mean	Standard Deviation	Standard Error
Overall Uncertainty				
GROUP 1	329	13.2310	3.370	.186
GROUP 2	348	12.5316	3.366	.180

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-tail Prob.	t Value	Degrees of Freedom	2-tail Prob.	t Value	Degrees of Freedom	2-tail Prob.
1.00	.981	2.70	675	.007	2.70	672.78	.007

Table 5

A N A L Y Z A B I L I T Y

\- - Correlation Coefficients - -

	ANA1	ANA2	ANA3	ANA4
ANA1	1.0000	.4808**	.4898**	.4664**
ANA2	.4808**	1.0000	.3354**	.3565**
ANA3	.4898**	.3354**	1.0000	.7708**
ANA4	.4664**	.3565**	.7708**	1.0000

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

Table 6

QUARTILE SPLIT TEST FOR ANALYZABILITY (IND.) AND UNCERTAINTY (DEP.)
Results of t-tests for independent samples:

GROUP 1 - Low Analyzability
GROUP 2 - High Analyzability

Variable	Number of Cases	Mean	Standard Deviation	Standard Error
UNCERTAINTY				
GROUP 1	342	2.7086	.706	.038
GROUP 2	261	2.4034	.608	.038

		≥ Pooled Variance Estimate			≥ Separate Variance Estimate		
F Value	2-tail Prob.	t Value	Degrees of Freedom	2-tail Prob.	t Value	Degrees of Freedom	2-tail Prob.
1.35	.011	5.58	601	.000	5.69	592.24	.000

Table 7

\- - Correlation Coefficients - -

	VARIETY	DYNAMISM	PREDICT.	UNCERTY.	EQUIV.
VARIETY	1.00	.07*	-.01	-.10**	.22**
DYNAMISM	.07*	1.00	-.19**	.07*	.33**
PREDICT.	-.01	-.19**	1.00	-.37**	-.17**
UNCERTY.	-.10**	.07*	-.37**	1.00	.27**
EQUIV.	.22**	.33**	-.17**	.27**	1.00

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

Table 8

I M P O R T A N C E O F O R A L M E D I A

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Very Unimportant	1	15	1.5	1.5	1.5
	2	16	1.6	1.6	3.1
	3	45	4.5	4.5	7.6
	4	240	23.9	24.1	31.8
Very Important	5	679	67.5	68.2	100.0
not answered	9	11	1.1	Missing	
	Total	1006	100.0	100.0	

Mean	4.56	Median	5.00	Mode	5.00
Std dev	.78	Range	4.00	Minimum	1.00
Maximum	5.00				

I M P O R T A N C E O F W R I T T E N M E D I A

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Very Unimportant	1	14	1.4	1.4	1.4
	2	41	4.1	4.1	5.5
	3	143	14.2	14.4	19.9
	4	412	41.0	41.4	61.3
Very Important	5	385	38.3	38.7	100.0
not answered	9	11	1.1	Missing	
	Total	1006	100.0	100.0	

Mean	4.12	Median	4.00	Mode	4.00
Std dev	.90	Range	4.00	Minimum	1.00
Maximum	5.00				

Table 8, cont'd.

I M P O R T A N C E O F E-M A I L

	Value	Frequency	Percent	Valid Percent	Cum Percent
Very Unimportant	1	46	4.6	5.8	5.8
	2	84	8.3	10.6	16.5
	3	140	13.9	17.7	34.2
	4	177	17.6	22.4	56.6
Very Important	5	343	34.1	43.4	100.0
	.	201	20.0	Missing	
not answered	9	15	1.5	Missing	
	Total	1006	100.0	100.0	

Valid cases 790 Missing cases 216

I M P O R T A N C E O F V O I C E M A I L M E D I A

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Very Unimportant	1	222	22.1	22.6	22.6
	2	203	20.2	20.7	43.2
	3	217	21.6	22.1	65.3
	4	210	20.9	21.4	86.7
Very Important	5	131	13.0	13.3	100.0
not answered	9	23	2.3	Missing	
	Total	1006	100.0	100.0	

Mean	2.82	Median	3.00	Mode	1.00
Std dev	1.35	Range	4.00	Minimum	1.00
Maximum	5.00				

Table 9

S U B J E C T S' U S E O F N E T W O R K S

	Value	Frequency	Percent	Valid Percent	Cum Percent
Yes, I personally use them	1	724	72.0	72.9	72.9
Yes, but through intermediary	2	68	6.8	6.8	79.8
No, because I have no access	3	118	11.7	11.9	91.6
No, although I do have access	4	83	8.3	8.4	100.0
not answered	9	13	1.3	Missing	
	Total	1006	100.0	100.0	

Valid cases 993 Missing cases 13

Table 10

Number of electronic bulletin board uses per week

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
None	0	468	46.5	63.8	63.8
	1	87	8.6	11.9	75.6
	2	57	5.7	7.8	83.4
	3	17	1.7	2.3	85.7
	4	10	1.0	1.4	87.1
	5	59	5.9	8.0	95.1
	6	2	.2	.3	95.4
	7	3	.3	.4	95.8
	8	3	.3	.4	96.2
	9	1	.1	.1	96.3
	10	14	1.4	1.9	98.2
	13	1	.1	.1	98.4
	15	4	.4	.5	98.9
	20	5	.5	.7	99.6
	50	1	.1	.1	99.7
	97	1	.1	.1	99.9
	100	1	.1	.1	100.0
	.	201	20.0	Missing	
not answered	999	71	7.1	Missing	
	Total	1006	100.0	100.0	

Mean	1.653	Median	.000	Mode	.000
Minimum	.000	Maximum	100.000		

Table 11

Number of e-mail messages per week

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
None	0	134	13.3	17.4	17.4
	1	88	8.7	11.4	28.9
	2	63	6.3	8.2	37.1
	3	28	2.8	3.6	40.7
	4	17	1.7	2.2	42.9
	5	100	9.9	13.0	55.9
	6	10	1.0	1.3	57.2
	7	13	1.3	1.7	58.9
	8	11	1.1	1.4	60.3
	10	105	10.4	13.7	74.0
	12	6	.6	.8	74.8
	14	1	.1	.1	74.9
	15	43	4.3	5.6	80.5
	16	1	.1	.1	80.6
	18	2	.2	.3	80.9
	20	54	5.4	7.0	87.9
	22	1	.1	.1	88.0
	25	22	2.2	2.9	90.9
	30	13	1.3	1.7	92.6
	35	4	.4	.5	93.1
	40	15	1.5	2.0	95.1
	50	21	2.1	2.7	97.8
	60	4	.4	.5	98.3
	80	1	.1	.1	98.4
	100	10	1.0	1.3	99.7
	150	1	.1	.1	99.9
	400	1	.1	.1	100.0
	.	201	20.0	Missing	
can't estimate	997	1	.1	Missing	
not answered	999	35	3.5	Missing	
	Total	1006	100.0	100.0	

Mean 11.235 Median 5.000 Mode .000
Minimum .000 Maximum 400.000

Valid cases 769 Missing cases 237

Table 12

Using networks to access computational tools per week

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
None	0	334	33.2	45.1	45.1
	1	72	7.2	9.7	54.9
	2	40	4.0	5.4	60.3
	3	26	2.6	3.5	63.8
	4	10	1.0	1.4	65.1
	5	73	7.3	9.9	75.0
	6	5	.5	.7	75.7
	7	6	.6	.8	76.5
	8	5	.5	.7	77.2
	9	1	.1	.1	77.3
	10	81	8.1	10.9	88.2
	11	1	.1	.1	88.4
	12	1	.1	.1	88.5
	13	2	.2	.3	88.8
	15	14	1.4	1.9	90.7
	16	1	.1	.1	90.8
	20	33	3.3	4.5	95.3
	25	4	.4	.5	95.8
	30	9	.9	1.2	97.0
	35	1	.1	.1	97.2
	40	8	.8	1.1	98.2
	50	5	.5	.7	98.9
	75	1	.1	.1	99.1
	80	1	.1	.1	99.2
	100	5	.5	.7	99.9
	200	1	.1	.1	100.0
	.	201	20.0	Missing	
can't estimate	997	4	.4	Missing	
not answered	999	61	6.1	Missing	
	Total	1006	100.0	100.0	

Mean 5.853 Median 1.000 Mode .000
Std dev 13.883 Range 200.000 Minimum .000
Maximum 200.000

Valid cases 740 Missing cases 266

Table 13

Number of library searches per week using electronic networks

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
None	0	533	53.0	73.2	73.2
	1	103	10.2	14.1	87.4
	2	38	3.8	5.2	92.6
	3	13	1.3	1.8	94.4
	4	2	.2	.3	94.6
	5	24	2.4	3.3	97.9
	6	1	.1	.1	98.1
	7	3	.3	.4	98.5
	9	1	.1	.1	98.6
	10	7	.7	1.0	99.6
	20	2	.2	.3	99.9
	30	1	.1	.1	100.0
	.	201	20.0	Missing	
can't estimate	997	1	.1	Missing	
not answered	999	76	7.6	Missing	
	Total	1006	100.0	100.0	

Mean .717 Median .000 Mode .000
Minimum .000 Maximum 30.000

Valid cases 728 Missing cases 278

Table 14

Number of TELNET uses per week

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
None	0	351	34.9	47.7	47.7
	1	118	11.7	16.0	63.7
	2	80	8.0	10.9	74.6
	3	35	3.5	4.8	79.3
	4	9	.9	1.2	80.6
	5	55	5.5	7.5	88.0
	6	3	.3	.4	88.5
	7	5	.5	.7	89.1
	8	3	.3	.4	89.5
	10	40	4.0	5.4	94.9
	15	16	1.6	2.1	97.1
	20	14	1.4	1.9	99.0
	40	1	.1	.1	99.2
	50+	6	.6	.7	100.0
	.	201	20.0	Missing	
can't estimate	997	1	.1	Missing	
not answered	999	68	6.8	Missing	
	Total	1006	100.0	100.0	

Mean 3.042 Median 1.000 Mode .000
Minimum .000 Maximum 200.000

Valid cases 736 Missing cases 270

Table 15

Use of networks to control instruments per week

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
None	0	681	67.7	94.7	94.7
	1	17	1.7	2.4	97.1
	2	4	.4	.6	97.6
	3	4	.4	.6	98.2
	5	6	.6	.8	99.0
	9	2	.2	.3	99.3
	15	1	.1	.1	99.4
	20	2	.2	.3	99.7
	30	1	.1	.1	99.9
	40	1	.1	.1	100.0
	.	201	20.0	Missing	
can't estimate	997	1	.1	Missing	
not answered	999	85	8.4	Missing	
	Total	1006	100.0	100.0	

Mean .292 Median .000 Mode .000
Std dev 2.314 Range 40.000 Minimum .000
Maximum 40.000

Valid cases 719 Missing cases 287

Table 16

Number of papers prepared with colleagues via network

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
None	0	612	60.8	85.0	85.0
	1	65	6.5	9.0	94.0
	2	13	1.3	1.8	95.8
	3	5	.5	.7	96.5
	4	1	.1	.1	96.7
	5	13	1.3	1.8	98.5
	9	1	.1	.1	98.6
	10	6	.6	.8	99.4
	12	1	.1	.1	99.6
	15	2	.2	.3	99.9
	25	1	.1	.1	100.0
	.	201	20.0	Missing	
can't estimate	997	1	.1	Missing	
not answered	999	84	8.3	Missing	
	Total	1006	100.0	100.0	

Mean .432 Median .000 Mode .000
Std dev 1.776 Range 25.000 Minimum .000
Maximum 25.000

Valid cases 720 Missing cases 286

Table 17

Number of FTP transfers per week

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
None	0	207	20.6	27.8	27.8
	1	137	13.6	18.4	46.2
	2	90	8.9	12.1	58.3
	3	38	3.8	5.1	63.4
	4	12	1.2	1.6	65.0
	5	110	10.9	14.8	79.7
	6	7	.7	.9	80.7
	7	4	.4	.5	81.2
	8	5	.5	.7	81.9
	9	1	.1	.1	82.0
	10	71	7.1	9.5	91.5
	11	2	.2	.3	91.8
	12	1	.1	.1	91.9
	15	9	.9	1.2	93.2
	17	1	.1	.1	93.3
	18	1	.1	.1	93.4
	20	21	2.1	2.8	96.2
	25	5	.5	.7	96.9
	28	1	.1	.1	97.0
	30	2	.2	.3	97.3
	35	1	.1	.1	97.4
	40	1	.1	.1	97.6
	50	9	.9	1.2	98.8
	60	1	.1	.1	98.9
	70	1	.1	.1	99.1
	75	2	.2	.3	99.3
	100	4	.4	.5	99.9
	200	1	.1	.1	100.0
	.	201	20.0	Missing	
can't estimate	997	2	.2	Missing	
not answered	999	58	5.8	Missing	
	Total	1006	100.0	100.0	

Mean 5.503 Median 2.000 Mode .000
Std dev 13.288 Range 200.000 Minimum .000
Maximum 200.000

Valid cases 745 Missing cases 261

Tables of Demographic Data

Highest academic degree

	Value	Frequency	Percent	Valid Percent	Cum Percent
No degree	1	6	.6	.6	.6
Bachelors	2	292	29.0	29.3	29.9
Masters	3	438	43.5	44.0	74.0
Doctorate	4	198	19.7	19.9	93.9
Post-Doctorate	5	47	4.7	4.7	98.6
Other	6	14	1.4	1.4	100.0
	9	11	1.1	Missing	
	Total	1006	100.0	100.0	

Valid cases 995 Missing cases 11

Present professional duties

	Value	Frequency	Percent	Valid Percent	Cum Percent
Research	1	175	17.4	17.6	17.6
Teaching/Academic	2	55	5.5	5.5	23.1
Administration/Manag	3	231	23.0	23.2	46.3
Design/Development	4	314	31.2	31.5	77.8
Manufacturing/Produc	5	18	1.8	1.8	79.6
Service/Maintenance	6	22	2.2	2.2	81.8
Marketing/Sales	7	54	5.4	5.4	87.2
Private Consultant	8	34	3.4	3.4	90.7
Other	9	93	9.2	9.3	100.0
	99	10	1.0	Missing	
	Total	1006	100.0	100.0	

Valid cases 996 Missing cases 10

Types of organizations

	Value	Frequency	Percent	Valid Percent	Cum Percent
Academic	1	75	7.5	7.6	7.6
Government	2	225	22.4	22.7	30.3
Industry	3	578	57.5	58.4	88.7
Not for Profit	4	48	4.8	4.8	93.5
Other	5	64	6.4	6.5	100.0
	9	16	1.6	Missing	
	Total	1006	100.0	100.0	

Valid cases 990 Missing cases 16

Involvement in Aerospace

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Working in aerospace	1	996	99.0	99.0	99.0
Retired from aerospcace	2	7	.7	.7	99.7
Working, but not in aerospace	3	3	.3	.3	100.0
	Total	1006	100.0	100.0	

Type of academic preparation

	Value	Frequency	Percent	Valid Percent	Cum Percent
Engineer	1	838	83.3	84.1	84.1
Scientist	2	109	10.8	10.9	95.0
Other	3	50	5.0	5.0	100.0
	9	9	.9	Missing	
	Total	1006	100.0	100.0	

Valid cases 997 Missing cases 9

Gender of subjects

	Value	Frequency	Percent	Valid Percent	Cum Percent
Female	1	55	5.5	5.5	5.5
Male	2	939	93.3	94.5	100.0
	9	12	1.2	Missing	
	Total	1006	100.0	100.0	

Valid cases 994 Missing cases 12

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